

REMARKS

Claim 24 has been amended to depend from newly added process claims, and to incorporate the crystallinity limitation of claim 25. Claims 25 and 26 have been canceled.

New claims 27-32 have been added to claim certain aspects of the invention.

Claim 27 is generally supported at page 2 lines 11-17 of the specification. The lower limit on carbon dioxide content is supported at page 5 lines 31-32; the closed cell limitation is found at page 9 lines 27-29; and the limitation regarding the proportion of polymerized lactic acid units is found on page 3 line 3.

Claim 28 is supported by page 10 line 18 through page 11 line 12.

Claim 29 is supported at page 3 lines 20-22.

Claim 30 is supported at page 5 line 31 to page 6 line 2.

Claim 31 is supported at page 7 lines 23-24.

Claim 32 is supported by page 4, first full paragraph, and by original claim 12.

Regarding the rejections over USP 5,134,171 (Hammel) alone

The examiner cites Hammel as anticipating or rendering obvious the subject matter of claims 24 and 25, as presented previously.

The anticipation argument rests on an inherency argument. The examiner's position is that because Hammel discloses an extruded polylactide foam, that foam must have the crystallinity characteristics mentioned in claim 24.

Crystallinity is not an inherent property of polylactide resins (or any particular grade of polylactide resins), nor is it an inherent property of foamed polylactide resins. Instead, the crystallinity of any particular polylactide article (whether it be a foam or in some other form) depends on many factors, including certain attributes of the resin itself, and the presence of other materials, but just as importantly if not more so, on the thermal history of the article. Therefore, the manner in which the article is manufactured bears heavily on its crystallinity.

The applicants discuss the effect of heat history at pages 10-11 of their specification. As is clearly stated there, crystallization is not an inherent part of the extrusion foaming process. To the contrary, crystallization develops mainly in a subsequent heat-annealing step. In Example 4, applicants show that extruded polylactide foam does not inherently

have a crystallinity of from 13 to 24 J/g, even when made using large quantities of CO₂, as in this invention.

The Kanada article, cited by applicants in this case, also describes that the crystallization of PLA resin is time-dependent and temperature-dependent, as well as being affected by the presence of carbon dioxide. Kamada clearly shows that the crystallinity of a specific PLA article can vary, depending on its heat history. In this way, Kamada shows that crystallinity is not an inherent property of the resin itself, but is instead a result of various factors in addition to the mere composition of the resin.

Hammel describes a process in which a PLA resin is extruded into foam. Carbon dioxide is one of several blowing agents described. Hammel does not describe how much carbon dioxide is to be used, other than in Example 8. In Example 8, 2.16 pounds of carbon dioxide are used per 495.34 pounds of PLA resin. This comes to 0.44% carbon dioxide, based on resin weight, or less than 10% of the minimum amount specified by applicants' claims. In addition, Hammel does not describe any heat-annealing step.

Therefore, the manner in which Hammel's extruded foam is made differs from the process in which the claim 24 foam is made. Because Hammel's foams are made differently, and because those differences relate to factors that affect the crystalline properties of the foam product (in particular post-extrusion heat-annealing), Hammel does not describe any foam that inherently has the crystallinity characteristics of the foams of claim 24. As mentioned, applicant's example 4 demonstrates that extruded polylactide foam does not inherently have those crystallinity limitations.

As far as obviousness goes, Hammel does not mention crystallinity, does not describe any desire to develop crystallinity, and does not describe any ways in which crystallinity can be developed in his extruded PLA foams. There is no basis in Hammel to make any changes in his process whatsoever, in order to obtain a more crystalline foam material. Even if one wanted to modify Hammel to make a more crystalline foam, one would have no guidance of how to do so. More specifically, one would have no reason to select a particular blowing agent, and use that blowing agent in quantities that exceed those used by Hammel by an order of magnitude.

Regarding the rejection over the combination of Hammel and JP2003-073495 (Shinohara)

This rejection is moot in view of the cancellation of claim 26. Nonetheless, the applicants offer the following comments, as claim 24 now contains process limitations

similar to those of canceled claim 26, and also in the event that the examiner may consider applying the same or similar rejection against the newly added process claims.

JP 2003-073495 is different from Hammel and the present invention in that it describes a bead foaming process. This is a fundamentally different type of process than extrusion foaming, and produces a different type of product. Bead foams are made by forming lightly crosslinked polymer beads, impregnating them with a blowing agent, placing the beads in a mold, and gently heating the beads so that they soften slightly and the blowing agent expands. The softened beads stick together during this process, to form a molded piece. Bead foams of this type are used to make articles such as disposable drinking cups and inexpensive food and beverage coolers which are designed for temporary use. These products are easily recognized because the bead structure is retained. The product often can be picked apart manually by pulling individual beads away from the structure.

Because Shinohara's bead foam process is fundamentally different from an extrusion foaming process such as Hammel's, one skilled in the art would not look to Shinohara for guidance as to ways to modify Hammel.

The examiner points to a desire to improve "die shape reproducibility" and "weld nature" as a reason that one would turn to Shinohara to modify Hammel. Die shape reproducibility and weld nature are characteristic problems with bead foam processes, but are of no importance in extrusion foam processes. "Die shape reproducibility" relates to the surface smoothness of the bead foam product, and so is a concern that is specific to bead foam process (which involve a molding step in which particles are welded together), but is not applicable to extrusion foaming. "Weld nature" refers to how well the particles stick together in a bead foam process. Extrusion foaming processes are not concerned with welding particles together, and so weld nature is again of no concern in an extrusion process such as Hammel's. One would not logically combine Shinohara with Hammel in order to improve properties that are of no significance to Hammel's process.

One important difference between Hammel's extrusion process and a bead foam process such as Shinohara's is temperature. In an extrusion process, it is of course necessary to melt the resin to allow it to flow through the extruder and out of a die. A bead foam process such as Shinohara's must avoid such operating temperatures, because it is necessary to retain the bead structure throughout the process.

Shinohara is very specific about temperatures. In paragraph [0017], Shinohara ties operating temperature to carbon dioxide concentration, using the inequality

$$3 < \text{ambient temperature} < -2.5X + 55$$

where X is the carbon dioxide concentration and “ambient temperature” is the temperature in °Cat which Shinohara’s beads are impregnated. Note that the ambient temperature can never be above 55°C, according to Shinohara. At a carbon dioxide concentration of 5% (the lowest permitted by applicant’s claims), the ambient temperature according to Shinohara cannot exceed 42.5°C. Both 55°C and 42.5°C are well below the softening and melting temperatures of PLA resins. PLA cannot be extruded at such low temperatures.

Therefore, if one were to try to take Shinohara’s teachings over to Hammel, one would have to decrease the operating temperature of Hammel’s extruder to the point at which the PLA resin would solidify and could no longer be extruded. This leads directly to an inoperable process, which again underscores the point that Shinohara and Hammel are talking about two vastly different things.

Applicants direct the examiner’s attention to another reference that was cited by applicants, JP 2002-322,309A. Comparative example 4 (paragraph [0041]) of that reference describes an attempt to extrude PLA using 4.5% carbon dioxide as a blowing agent. The foam had an internal cavity (which means that the foam collapsed) and “did not turn into good foam”. If there was any basis at all to try to modify Hammel on the basis of Shinohara, JP 2002-322,309, that basis would be completely undermined by JP 2002-322,309 which shows that attempts to increase carbon dioxide in PLA foam processes failed.

JP 2002-322,309 underscores the unexpected nature of applicants’ invention. The art shows that carbon dioxide can be used at low levels (Hammel), but attempts to use somewhat larger amounts fail. The art, when considered together, clearly discourages any attempt to increase carbon dioxide loading in an extrusion foaming process, notwithstanding Shinohara’s teachings with regard to a different method.

The present claims define subject matter that is novel and inventive over the cited references. A notice of allowance is respectfully requested.

Respectfully submitted,
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